The ABC's of the Real Business Cycle

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The Real Business Cycle theory Is it a viable

This is the question As a new theory

Time will only tell

ABSTRACT (100-200 WORDS): The Real Business Cycle approach to business cycle theory is viable and worthy of extended research. However, it does not resolve the dilemma facing business cycle theorists in coming up with one true explanation of the cycle. Throughout my research paper, I have clearly defined its shortcomings in terms of the non-recognition of money and a refusal to incorporate aggregate demand into the model. As a new theory, my purpose was to gain an enlightened view of what many feel is a revolutionary new way of business cycle thinking. I started with an explanation of what the theory holds as its premise and detailed the theory in action with the use of a simple Real Cycle model. My research was confined mainly to current Economic periodicals along with a few books by Real Business Cycle proponents. While I am a novice in the field of business cycle studies, I feel my paper offers a generous overview of the Real Business Cycle and is accessible to both the layman and expert as well. Hopefully, the reader will be intrigued by my paper and will find it to be an adequate discussion of business cycle analysis.

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The ABC's of the Real Business Cycle

Ever since the advent of an industrialized society, one of the most interesting yet intriguing questions facing economists is formulating a plausible explanation for the ups and downs of the economy. Throughout time, a wide variety of theories have been proposed, ranging from the critical role of private investment of J.B. Clark to the underconsumption approach of Thomas Malthus. However, none have been able to withstand the test of innovation as countless economists are striving each year to find a breakthrough in business cycle theory. The business cycle is a major issue both inside and outside of the political arena and is worthy of the research it demands today. As Charles Plosser notes, "When we think of business cycles, we frequently think about notions of persistence or serial correlation in economic aggregates; comovement among economic activities; leading or lagging variables relative to output; and different amplitudes or volatilities of various series" (53). One strand of thought growing out of the 1980's fits this definition quite well in a theoretical sense. The Real Business Cycle theory (RBC) has generated a fervor among business cycle analysts and offers a great deal of hope in unraveling the mystery of defining what causes a cycle. Is it a viable explanation for the cycle or merely a "catch-phrase" theory for 1980's? This is the question that is looking for an answer.

Up until the 1930's, the classical economists' reliance on supply-side effects as the major cause of changes in aggregate economic activity dominated macroeconomic thinking. However, it

was Keynes' General Theory in 1936 which swung the pendulum over to the demand side and provided the impetus for a demand versus supply side explanation of the business cycle which still exists today. Thomas E. Hall details, "His revolution was successful because for the past fifty plus years the major business cycle theories have been based on the instability of aggregate demand" (121). The major modern demand-side theories (monetarist, rational expectations and new Keynesian) have the two important tenets of a reversion of real GNP to its trend value and the belief that real wages are countercyclical following changes in aggregate demand because of incorrect price expectations (Hall 21). These two points will be re-iterated later, but suffice it to say that the modern demand-side theories' inability to explain the tendency of the real wage to be procyclical or acyclical following a change in aggregate demand has generated the skepticism which led to the Real Business Cycle approach.

With the shortcomings of an aggregate demand approach and the appearance of supply shocks in the 1970's, economists turned the clock back to the classical days of stressing aggregate supply within the business cycle framework with an added twist. It is the Real Business Cycle theory which holds that it is real, rather than monetary factors which cause fluctuations in economic activity. Exogenous shocks to aggregate supply are the cause of all cycles and since shocks occur in all economies, cycles are indeed "natural" (Sherman 60). The RBC theory offers a twist to the classical theory in that it has the added feature of

predicting procyclical real wages. Like most other neoclassical theories, the RBC approach is ahistorical in that it suggests that all economies have cycles on the basis of theory rather than an extensive empirical survey (Sherman 60). While a Keynesian approach to the cycle enjoys this empirical success, its lack of what many consider a less than sound theoretical foundation has led to some skepticism. This point is highly debateable, thus meriting a further explanation.

The Keynesian interpretation of macroeconomic phenomenons, such as the business cycle, show an absence of foundation based on the choice theoretic framework of microeconomics (Plosser 51). Two papers, one by Milton Friedman in 1968 and the other by Robert Lucas in 1976 illustrate this point quite well. Friedman's approach engulfed the tradeoff between inflation and some measure of real output or unemployment, or the Phillip's Curve in textbook jargon. Such a tradeoff was a major feature of the Keynesian system of the 1960's. Friedman's argument showed that basic microeconomic principles placed a premise on the long run Phillip's curve being vertical. Thus, sustained inflation was compatible with any level of real demand of goods. A major tenet of Keynesian thinking was shown to be in contrast with microeconomic principles.

Lucas' contribution to the theoretical foundation question stressed that expectations about future policy will systematically influence current decisions and thus alter the behavioral relations exploited by implementation of the empirical

analysis (Plosser 52). Concurrently, expectations cannot be formulated or specified in arbitrary manner and be consistent with individual maximazation.

While both works point out theoretical shortcomings in the Keynesian framework, a more poignant fact arises out of a static versus dynamic economic state confrontation. The foundations of the Keynesian model are static and focus on determining output at a point in time, treating the capital stock as given. Dynamic elements through accelerator mechanisms and price or wage adjustment equations have been introduced into the model, but these elements did not arise from any theoretical framework of maximization but rather from simple behavior rules which either characterized agents or markets in general (Plosser 52). Dynamic adjustment was merely an empirical question as to which economist's formulation fit the data best. Keynesian models also start out asserting market failures and do not measure up to Hick's "idealized state." Hicks notes, "It is logically impossible to attribute an important portion of fluctuations to market failure without an understanding of the sorts of fluctuations that would be observed in the absence of the hypothesized market failure" (52). Theoretically, this static and dynamic economic system debate lessens, to a degree, the Keynesian theory of the business cycle.

I do not profess to claim that this is a complete discussion of the theoretical shortcomings of the Keynesian model. Nevertheless, a Keynesian discussion does have some "theoretical

holes" which has led to alternative explanations of the cycle. As a new theory, the Real Busines Cycle model has garnered an enormous amount of attention in a short period of time.

The theoretical foundation behind the Real Business Cycle theory is relatively straight-forward and best demonstrated by a simple model. It is difficult to offer one "true" model which encompasses the entire RBC approach because it is being revised to include such factors as to what role does money and aggregate demand play in the model? These points will be taken up later, but I feel it to be in the best interest of the reader to leave out the aforementioned questions and get to the heart of the RBC issue by concentrating on how exogenous shocks to aggregate supply can move through a simple model eloquently illustrated by Thomas E. Hall. The model is based on the premise of perfect competition with no externalities and assumes three things. First, after new goods are ordered, they take several periods to build. Second, following changes in income, households gradually adjust their consumption patterns over time. Third, the model assumes that wages and prices are perfectly flexible which ensures that all trading takes place in equilibrium (Hall 124).

Exogenous shocks can be the result of demographic changes, technology shocks, changes in relative input prices or changes in consumer preferences. Supply-side effects can best be illustrated by a Cobb-Douglas production function where real GNP (Y) is a function of labor input, (L) capital stock (K) and a term which picks up shocks to the production function (z).

$$Y = f(L, K, Z)$$

The shock term (Z) can further be illustrated and assumed to evolve around a constant term ( ) and a random error term with an expected value of zero (e).

$$z = +e$$

Shocks may occur in the economy which affect the production function (f) itself such as a major advancement in technology which allows a given stock of capital and labor to produce more output for a set price level. Similarly, shocks may affect the inputs of labor (L) and capital (K) availability. The "baby boom" and changes in the relative price of energy are two prime examples, respectively.

A major premise of the RBC theory is that the economy is constantly receiving exogenous shocks to the production function, whether they be major like a war, or more commonly smaller shocks to labor, capital and technology which have a positive trend value ( ) and a random component (e). The positive trend value denotes that, over time, positive influences on aggregate supply lead to growth. The random component ensures that the shocks, on average, have a neutral rather than a good or bad effect on economic activity.

One may erroneously conclude from the model and its neutral error term (e) with an expected value of zero that the various shocks cancel each other out in succeeding periods. Upon closer investigation, shocks can occur consecutively in successive periods. For example, if several positive shocks occur, output

grows more rapidly.

From a testing standpoint, the fact that technology shocks are unobservable is a drawback. In order to conduct empirical research as to the effect technological change has, researchers use Solow residuals. Going back to our production function and assuming that factors are paid their marginal products, data on the total shares of output going to an input can be used to infer the coefficients of the production function. Using these coefficients, it is possible to deduce what would be the change in GNP from one year to the next if only the inputs changed. Then, any difference between the actual change in GNP and the calculated change must be attributed to changes in technology (Rush 19).

With a basic introduction to an RBC model, how does the model explain persistent output changes? Persistence in the sense that output will tend to grow more than trend during expansions for several quarters and less than trend during a recession. If, as the model implies, economic fluctuations are caused by a series of shocks in the same direction or a single major shock, both should be able to explain persistent output changes. According to Hall, "In the case of a series of shocks in the same direction, we can easily see how this causes expansionary or contractionary pressure on output for several periods" (124). It is with the single exogenous shock where we can view Hall's model in action.

Hall assumes an economy in a steady state with a long run

economic growth rate of three percent and no random shocks so that our e value is zero. Introducing a single positive shock such as robot technology which makes production easier, firms which can benefit from such technology will immediately demand it. The producers of such demanded technology will see an increase in labor needed and because wage rigidities aren't assumed to exist, both employment and real wages rise (Hall 124). The time-to-build and smoothed consumption spending implications of the model lead to the important conclusion that since it will take several periods to fill new orders, households will continue to earn higher wages and will spread their increased consumption pattern from the higher wages over several periods. With increased spending by households over time, aggregate output and employment will grow more than trend for a number of periods. One can easily see that real wages behave in a procyclical manner as the technology shock increases the marginal products of both labor and capital and the subsequent increase in labor demanded raised both employment and the real wage. Such a conclusion is a major tenet of the RBC cause.

Eventually, the effect of the shock works its way through the economy. The new technology becomes embedded into the production pattern and the economy returns to a steady state equilibrium with a three percent growth rate. What must be made evidently clear is that the RBC approach assumes that the three percent growth rate takes place at a higher base level of output than before. Such an assumption puts the theory in direct

conflict with demand-side theories, a point that will be expounded upon later. As one can see, a single exogenous shock in the form of a technological advance has led to an increase in real GNP and offers a theoretical proof of the Real Business Cycle theory. In no way is this model deemed to be an all-encompassing entity of the RBC approach. Other models, most significantly those of Plosser (1982) and Kyland and Prescott (1982) are similar in nature and offer only a few expansions on the model presented here. While an RBC model may not enjoy the empirical success that a demand-side model can at the present, its theoretical foundation is valid and commands further research.

With a general understanding of what the RBC theory encompasses, it is its conflict with modern demand-side theories of the cycle where we now turn our attention. Such conflict keeps business cycle theorists divided as to which theory gives a truer approximation of the cycle. The conflict can best be described most accurately on the two fronts where the RBC approach differs radically from a demand-side approach. First is the argument over real GNP changes, are they real or transitory? Demand-side models propose that fluctuations in real GNP are only temporary deviations from the natural rate and, eventually, real GNP will return to this natural rate. The RBC model counters with the belief that output changes are permanent and there is no reason to believe that real GNP will return to a trend line. Here we see real GNP following a random walk pattern. While the

RBC theory relies very little on empirical proof, the resolution of the trend-reversion, random walk debate can only be settled empirically. Specifically, time series analysis is used and offers a way of tracking a variable's (real GNP) history through specific equations (Hall 127). The equation specific to the demand-side trend reversion model is

$$\ln Y = \ln Y + gT$$

where ln indicates natural logarithm, Y is real GNP, g is the trend rate of growth of real GNP, T is time and subscripted t represents the time period (Hall 127). Natural logs offer the handy property that if a variable has a constant growth rate, then any change in that variable's natural log will also be constant. By starting with the natural log of real GNP at any pre-determined time o and extrapolating the average growth rate of real GNP (3.2% per year since 1950), we are able to determine the log of natural real GNP ($\ln Y$) in any time period and see how real GNP grows. As previously mentioned, this trend-reversion model postulates that GNP is allowed to stray from the natural rate in the short run but must revert to the natural rate in the long run. An equation which describes this process is

$$\ln Y = \ln Y + B(\ln Y - \ln Y) + u$$

where Y is actual real GNP, B is a coefficient on lagged output deviations that lies between zero and one, and u is a term with an expected value of zero (Hall 128). The value of the $\ln Y$ is merely calculated from the previous equation. It is the B term, however, which is integral to this whole process. The trend-

reversion model claims this value lies between zero and one which ensures that whenever real GNP is not on the trend line, the tendency is for output to return to the trend line. One could plug a variety of numbers into the two equations and come up with a number of values of the natural log of real GNP and graph these values to see growth or contractions. It is within the B term where we will see real GNP return to its trend value. Suppose that B is 0.6. If a random shock raises real GNP 60 billion above trend, the next period that 60 billion will correspond to the time period t-1 and real GNP in period t will lie .6 * 60 or 36 billion above trend. The subsequent period will see real GNP lie .6 * 36 or 21.6 billion above trend. The point to be taken here is that eventually this number will reach zero and real GNP will return to the trend line.

The random walk hypothesis adds a slight twist to the aforementioned equations. Within this hypothesis, the B term is assumed to be one. If a positive shock hits the economy, the trend line will shift up by the amount of the shock and will continue on this path until a negative shock shifts it back down (Plosser 59). However, because the B term is assumed to be one, there is no reason to believe that real GNP will revert back to the trend line.

If the two models assume different values for B, which one is correct? Results using the equation

$$\ln Y = + B \ln Y + u$$

have shown that one cannot reject the hypothesis that B equals

one through empirical testing. Bennett Mc Callum has pointed out that such results could be taken in the wrong manner as the random walk hypothesis is true only if B is exactly equal to one. A B value of .99 would shift proof towards the trend-reversion model (Klein 45). According to Thomas E. Hall, "Being unable to reject the real business cycle claim that B equals one doesn't necessarily mean that we can reject the trend reversion model with B slightly less than one. As a result, the empirical evidence is not conclusive about whether real GNP follows a random walk or a trend reversion model because neither claim can be rejected" (131).

Turning our attention to an even more volatile issue between demand and supply discrepancies, it is the role of money in influencing output which is receiving the greatest amount of attention. A staunch real business cycle theory argues that, even in the short run, money doesn't influence output. Instead, output growth influences monetary growth. The modern demand-side theories, in contrast, place a heavy premise on monetary changes being the major cause of business cycles. Friedman and Schwartz's Monetary History of the United States in 1963 fostered enthusiasm in this belief as they argued that over the period 1867-1960, every economic expansion was accompanied with a rise in the monetary growth rate and every contraction accompanied by a lowering of the monetary growth rate (Rush 21). Such proven knowledge brought monetarism to the forefront of macroeconomic thinking and offered a solid explanation of monetary growth and

the business cycle. This belief came under fire in the early 1980's with Sims' vector autoregression model (VAR). A VAR specifies each variable in the system as a function of its own history and lagged values of other variables in the system (Hall 133). Sims' four equation VAR model included output, money, prices and interest rates. Each variable was isolated in a separate equation with the lagged value of this variable coupled with the lagged values of the other three being capable of explaining its current value. By empirically testing each equation with collected data values, one can deduce if interest rates, money or prices are statistically significant enough to influence output changes. What Sims concluded was that when interest rates were included in the output equation, interest rates influenced real GNP but money did not. (133). Other tests using vector autoregression models done by Litterman and Weiss in 1985 supported Sims' results (Rush 15). As in the case of the trend-reversion versus random walk hypothesis, empirical testing has been unable to settle once and for all the monetary issue. Both sides present poignant arguments and have a degree of empirical proof, yet the debate wages on.

The preceding discussion has dealt with many aspects of the Real Business Cycle theory. As a theory worthy of continued research and discussion, I find it to be a major part of the economic arena. As an all-encompassing solution to business cycle analysis, it fails on many counts. It would seem erroneous to back the original, straight-forward RBC approach. The

complete non-recognition of aggregate demand effects and the neutrality of money damper what is otherwise a revolutionary way of looking at the business cycle. In particular, the incorporation of a government sector into our simple model can have profound aggregate demand implications. Recently, Lawrence Christiano and Martin Eichenbaum have extended the RBC model to include government purchases of goods and services along with unemployment within its framework. Their results show that the correlation between productivity shocks and output is lowered. (Rush 18). By introducing a simple form of aggregate demand, a major aspect of the RBC model (that of productivity shocks significantly affecting output) is lowered. Also, raising government purchases induces a negative wealth effect which tends to reduce consumption and raise work effort and output. As increased household consumption from a productivity shock fuels real GNP growth greater than trend in our simple model, the inclusion of government purchases will tend to negate this consumption effect. While the jury is still out on how much of real GNP growth can be attributed to demand or supply-side disturbances, the complete exclusion of aggregate demand in favor of aggregate supply is a bit hasty.

The jury is still out, coincidentally, on the issue of money neutrality. The RBC belief that changes in money supply are the consequence of "reverse causation" that is, fluctuations in money supply are a response to output fluctuations initiated by technology shocks is a polar opposite of modern demand-side

theories (Klein 45). As previously discussed, one can find evidence to support both conclusions. While being someone who is still a novice in the field of business cycle studies, I nevertheless find it hard to conform to the belief that money is completely neutral. Sims' vector autoregression model has come under fire by Mc Callum in 1986 who argues that the findings are predictable because he uses data over a period when the Federal Reserve was targeting interest rates. By raising the federal funds rate, the public is coerced into holding less money. As the public reduces their quantity of money demanded, the quantity of money falls and real GNP lowers in the short run. The conclusion Mc Callum finds is, because of interest rate targeting, we find a correlation between interest rates and output when the true relation is between money and output (Hall 134).

What I see as a probable resolution to the neutrality of the money issue is a compromise by both sides. I feel the RBC approach needs to incorporate the money factor by modifying standard real cycle models. Such incorporation need not accept the monetary influence as a major part of the cycle, but it should at least recognize the possible influence monetary factors have. While the insight provided by the RBC model that broader money supply measures are endogenous is worthwhile indeed, narrow measures of money and their effects on economic activity must be taken into account of. Finn Kyland in 1989 introduces money into the model in two ways. First, he assumes that changes in the

money supply create confusion about the real wage. Given this confusion, people would react to unexpected changes in the money supply as if they were changes in real factors. Second, he introduces money as a means to conserve on transaction costs (Rush 21). In both instances, money can play a small role within the Real Business Cycle model.

Research into the Real Business Cycle theory is still in its infancy today. However, it has been poignant in the fact that it has pointed out that supply-side factors also can play a role in economic fluctuations. Charles I. Plosser points out that, "The appeal of this line of research is the apparent power of some very simple economic principles to generate dynamic behavior that was heretofore thought to be incompatible with any notion of equilibrium" (71). The reliance on analyzing only technological or productivity shocks seems to be waning as other shocks arising from preferences, government or even money have been shown to enhance the RBC framework. Time will only tell on how strong of an impact the RBC model will have on business cycle theory, but as a viable alternative to the demand-side approach, one cannot deny its influence in the area of business cycle studies.

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